Practice makes perfect

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Supplementary Online Material

Design and description of the course

The course consisted of three broad levels of challenge. At level 1 athletes were able to run, walk and jump along low beams or specific mats on the floor (ground locomotion off the designated mats was not allowed). These sections were interspersed between higher level challenges and replicated the relatively undemanding nature of broad, stout branches and boughs.

Level 2 challenges could be solved either by jumping, leaping, vaulting and swinging or by climbing and forelimb- and/or hindlimb-dominated scrambling/clambering. Vaulting horses, wall bars, large square and rectangular foam blocks, spring boards, trampolines and vertical ropes (for horizontal not vertical movement) are typical examples. These were often used to make arboreal links between major obstacles and to further incorporate compliance, irregularity and discontinuity. In addition, many of the ground mats that the athletes were allowed to use finished some distance before the next available support so that the participants were forced to cross a small gap, either by jumping or by clambering more slowly, using multiple limbs.

At Level 3 the obstacles were more challenging and were designed to allow greater variation in response. There were five obstacles at this level. The first level 3 obstacle consisted of a set of uneven bars (2.5 m and 1.7 m high) followed by a single high bar (2.5 m high) with a rectangular block between the two sets of bars and another tied loosely under the low uneven bar. Participants first encountered the low uneven bar and block. Most participants jumped onto the red block to scramble across the bar, although some slipped between the red block and bar. They then stood and either jumped to the high uneven bar or could reach it from a standing position. A few however jumped directly onto the lower bar and from this jumped directly to swing on the 1st high bar. All participants then landed on the middle block,

jumped to swing on the single high bar, and dropped to the ground, although they achieved varying distances from the obstacle in the final push off.

The second Level 3 obstacle emulated challenges caused by support irregularity and discontinuity. It consisted of two sets of 3.5 m parallel bars, positioned at angles to each other. The first set the athletes encountered was positioned in an X formation (with the end of the bars ranging between 1.2 m and 2.05 m above the ground) and the second set was positioned with one bar at its highest (1.93 m) setting and the other at its lowest (1.2 m) setting. The access mat was positioned about 1m away from the X bars, so the subjects had to cross a small gap to access the bars. Some athletes jumped onto the 1st set of bars, while others used a bimanual pull-up and others reached and climbed vertically. Many participants crossed the X bars by clambering above them, first with a pronograde and then an orthograde posture, although others used hand-assisted and unassisted bipedalism or alternatively used forelimb swing underneath the bars. Once on the second set, many exhibited bipedalism or hand-assisted bipedalism, although some maintained a rather pronograde trunk posture.

It proved very difficult to emulate the mechanics of meshes of compliant branches and foliage, so instead we mimicked the functional sapping of momentum and energy that this habitat imparts on apes with the use of foam pits. The next level 3 obstacle consisted of a sunken narrow foam pit (ca. 1.4m depth, 4.90 m in length) with a single 4 cm diameter bar above the middle. Three strategies were used to solve this obstacle. Participants either: 1) jumped into the foam, waded through the pit and bimanually pushed themselves out of the end, 2) jumped to swing on the bar, landed close to the far end and bimanually lifted themselves out, or 3) jumped to swing on the bar and were able, either by virtue of technique or repeated swings, to land on the ground rather than in the pit.

The 4th level 3 challenge was designed to emulate continuous suspensory locomotion along a branch. It consisted of a 4.9m stretch of steel girder (2.62m off the ground) with two hanging rings positioned at the access point. At the end of the girder, participants could drop onto a mat and walk/run to a trampoline, or could swing directly onto the trampoline, using the potential energy from the drop to reduce the bounces required to jump to the next obstacle. Some participants used the hoops to unimanually pull up and reach the girder, while others jumped directly to the girder. Once on it, most participants used sideways forelimb swing or flexed or extended elbow forelimb swing. Some exhibited the trunk rotations indicative of true brachiation towards the end of the sequence, and one participant used an inverted pronograde scramble, although they changed to sideways forelimb swing by the 4th iteration. Among those that brachiated or used forelimb swing, some subjects employed a fast, gait with a long stride length (Fig. 1e), while others were slower, with a short stride length and greater sideways displacement (Fig. 1f).

The final level 3 challenge required the athletes to cross an 18 m long foam pit. It was structured such that it was possible to reduce time in the foam by leaping between 3 large mats placed on the foam, and/or by using a set of uneven bars situated above the middle of the pit. Most participants used a trampoline to jump to the first mat without falling into the foam and many could then jump to the second mat, either not entering the foam or only having to take a single step to reach mat 2. At this point most jumped as far as possible from mat 2 and waded through the foam to mat 3. However some climbed from mat 2 onto the frames of the high bars and subsequently swung from the lower bar towards mat 3, although many did not manage to reach it. One participant performed a standing jump out of the foam pit to the lower bar, bimanually pushed up so that his waist was on the bar and then swung to the 3rd mat. When in the foam, some participants maintained a bipedal posture whereas others moved in a more quadrupedal fashion, spreading their weight among all four limbs.

SOM Figure S1

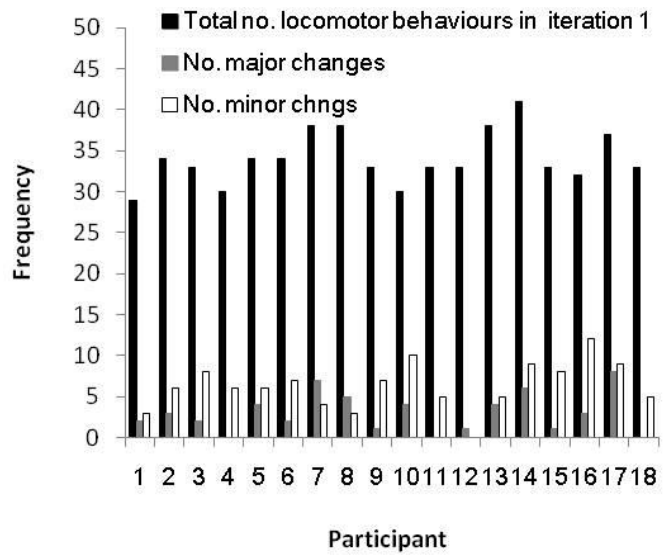

Fig. S1. Summary of the number of locomotor behaviours used to traverse the course. The first bar depicts the total number of locomotor behaviours used to complete the 1st iteration of the course for each athlete. Locomotion is generally classified into modes and submodes. The former distinguishes between fundamentally different behaviours (e.g. quadrupedalism and vertical climb) and the latter between biomechanically distinct types of a single behaviour (e.g. brachiation and forelimb swing are both classed under a torso-orthograde suspension mode). The 2nd and 3rd bars reflect the number of mode and submode changes each athlete made between the 1st and 4th iteration of the course. (*n*=18 since video data is missing for one athlete due to equipment failure).

Figure S2

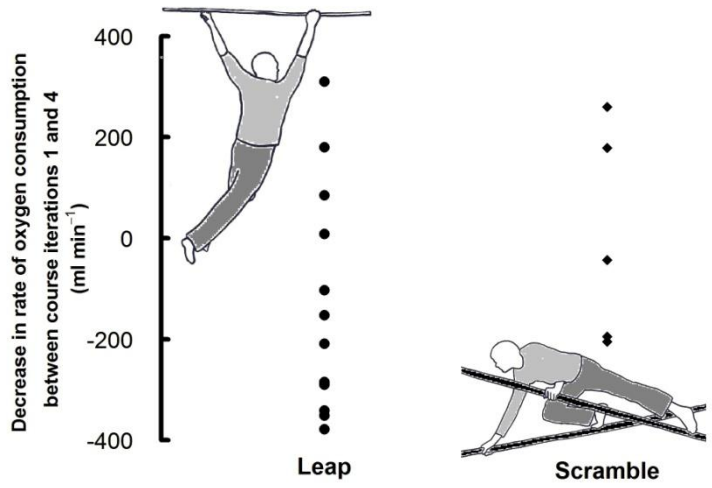

Fig. S2. The association between change in rate of oxygen consumption from course iterations 1 to 4 and locomotor profile.

SOM Movie Legend

Examples of locomotion on the course. The course consisted of a variety of generic gymnasium apparatus to emulate the range of mechanical conditions great apes experience when travelling along arboreal pathways. Thus parts of it incorporated support compliance, irregularity and discontinuity to reflect the conditions experienced during gap crossing between tree crowns, while others were rigid and predictable to reflect the phases between bouts of gap crossing when even large-bodied apes may walk into and out of the core of a tree along thick boughs (full details are presented in the 'Design and description of the course' section above). This movie presents a collation of the different techniques parkour athletes used to traverse some components of the course.